International Journal of Metallurgical & Material Science and Engineering (IJMMSE)
ISSN(P): 2278-2516; ISSN(E): 2278-2524
Vol. 4, Issue 1, Feb 2014, 25-30

DEVELOPMENT AND EVALUATION OF MECHANICAL PROPERTIES ASBESTOS FILLED E-GLASS/EPOXY COMPOSITES

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ABSTRACT

Composite materials are the class of materials which has lot of scope in the field of several engineering applications such as structural, transport etc. But its application has limited because 100% replacement of composite with conventional metals/alloys is not possible while considering the properties. Lot of research and study is needed in this regard to develop the composite material as a promising material that is comparable with conventional metals/alloys. Attempt has been made in this work to develop and characterize epoxy based e-glass and asbestos powder filled composites by varying the asbestos powder from varying from 0 to6 vol. % in the epoxy matrix by hand layup technique.

KEYWORDS: Asbestos Powder, Epoxy, E-Glass, Hand Layup

INTRODUCTION

Composite materials generally defined as the combinations of two or more materials that result in the different properties than that of parent materials [1]. The advantage of Fiber composite technology is the high strength and high stiffness of fibers, which are combined with matrix materials of similar/dissimilar natures in various ways, creating ineluctable interfaces. Both the fiber and the matrix retain their original physical and chemical identities, but they together produce a combination of mechanical properties that cannot be achieved with either of the constituents acting alone, which is due to the presence of an interface between these two individual constituents [2]. Many research works have been already done on the fiber reinforced polymer based composites, and still there are many things to achieve regarding the mechanical and chemical properties.

It has been indicated that the E-glass/epoxy Composites found a wide variety of applications in structural, transportation, electronic fields. But use of this type of composite as a replacement of conventional metals is presently has lot of constraints in terms of mechanical properties, thermal properties etc.

E-glass/epoxy Composites can be prepared with the different particulate reinforcements such as granite powder, silicon carbide, glass powder, asbestos etc. The selection of materials is based on the experience and experimentation. An attempt has been made this work to evaluate the structure and characteristics of the Asbestos Powder Filled E-glass/epoxy Composites.

MATERIALS USED

Matrix Material: Epoxy is chosen as a matrix material. It is a chemical, widely used in industry because of their strong adhesive properties, chemical resistance, and toughness. Common two-part epoxy resin system contains epoxy resin, catalyst,/curing agents, and diluents and/or allergic contact reactions. Cured epoxy resin

(the fully hardened combination of epoxy resin chemicals) should neither irritate nor sensitive. Following table shows the important properties of general available epoxy resin.

Table 1

Properties	
Axial Modulus of elasticity (MPa)	46.88
Transverse Modulus of elasticity (MPa)	46.88
Coefficient of thermal expansion (µm/m/°C)	63
Coefficient of moisture expansion (m/m/kg/kg)	0.33
Specific Gravity	1.2

Reinforcement Materials

- E-glass fiber: E-glass is popular fiber made primarily of silica oxide, along with oxides of aluminum, boron, calcium and other compounds. Named for its good electrical resistance E-glass is strong yet low in cost, and accounts for 90% of glass fiber reinforcements. Over 90% of the glass fiber is held by so called E-glass, used mainly in a polyester matrix. Following table shows the important properties of general available E-glass fiber.

Table 2

Properties	
Axial Modulus of elasticity (MPa)	12.33
Transverse Modulus of elasticity (MPa)	12.33
Coefficient of thermal expansion (µm/m/°C)	$3.93e^5$
Axial tensile strength (MPa)	1544
Specific Gravity	2.5

Asbestos Powder

Asbestos is the name given to a group of fibrous, naturally occurring silicate minerals. They generally exist in nature in metamorphic or altered basic and ultra basic igneous rocks. Asbestos is resistant to heat and most chemicals (most forms are chemically inert). The fibers do not evaporate into air or dissolve in water. They have no odor or smell and do not migrate through soil. Indeed, even in prehistoric times, it was considered to be the wonder mineral that had limitless uses. In modern times at least 5,000 different products have been manufactured from asbestos. In this work asbestos powder is chosen had varied from 0 to 6 vol% in the resin matrix.

Hardener

The choice of hardener is governed by the curing temperature, pot life and curing temperature required as well as the application method used. Some of the hardeners along with resins for the preparation of laminates are HY 951, HY 972, HY 974 and HZ 978. Hardener used in this work is HY951 type with a proportion of 1:10 with the epoxy resin.

Physical Properties

Table 3: Showing Physical Properties of HY 951 Hardener

Color	Colorless
Odor	Ammonia
Physical state	Liquid
Solubility in water	Miscible
pH	13
Percent volatile	Nil

Table 4 Specification of Hardener HY 951

Property	Units	Values
Specific gravity at 25°C	g/cm^3	0.98
Flash point	°C	110
Viscosity at 25°C	MPa s	10-20

EXPERIMENTATION

Composite Preparation

The Glass/Epoxy composites used in this work is fabricated by using hand layup technique. The procedure consisted of placing the glass fibers with epoxy compactable finish on a substrate material which had a release coat applied on it. A curing agent (hardener) is mixed in the liquid epoxy to polymerize the polymer and form a solid network cross-linked polymer. Weighed quantities of room temperature curing epoxy resin plus hardener applied over the glass fabric. On this, another layer of the glass fabric was laid and the process continued. The whole was covered with a mat finished fabric over which steel plate was placed with the necessary release coat applied on it. The layup assembly was pressed in press. The excess resin was allowed to squeeze out. The laminate was cured at ambient conditions for a period of about 24hrs. The laminate so prepared has a 300mm X 300mm X 3mm

Table 5

% of Volume of Asbestos Filled	Matrix Volume %		Reinforcement Volume %	
0	Epoxy	50	Glass fiber	50
2	Epoxy	48	Glass fiber	50
4	Epoxy	46	Glass fiber	50
6	Epoxy	44	Glass fiber	50

To prepare the filled glass/epoxy composites, fillers are mixed with a known amount of resin. The details of composite prepared are shown in the table below.

TESTING METHODS

Sem Analysis

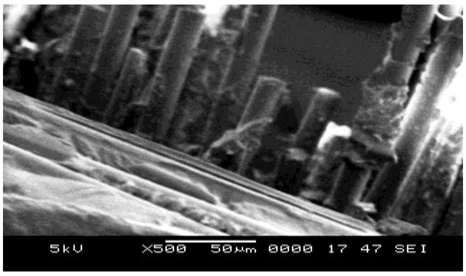

Figure 1: 0% Filled Tensile Specimen

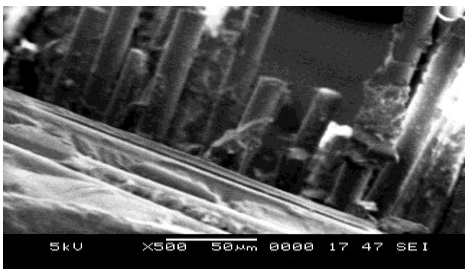

Figure 2: 2% Filled Tensile Specimen

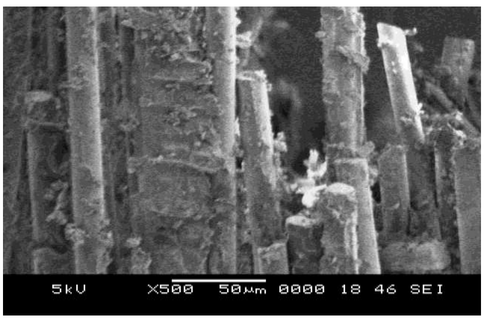

Figure 3: 4% Filled Tensile Specimen

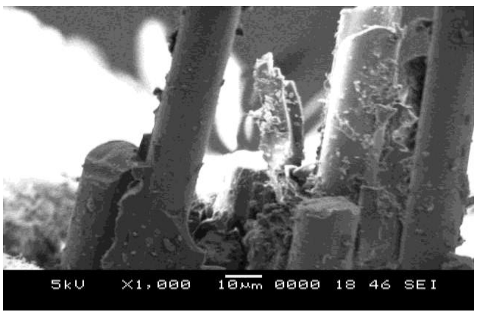

Figure 4: 6% Filled Tensile Specimen

The structural analysis of tensile test specimens was done using scan electron microscopy. From that figure we can clearly see the fiber breakage at the end. From figure.1, 2, 3, 4 it is found that fracture is due to fiber breakage at the surfaces and de-lamination of the fibers. And from figure it is revealed that fracture is due to de-lamination of the fibers. De-lamination of the fiber may be found due to weak bonding between the fibers. From the above figures it is revealed that it has good surface finish and has more surface area for interaction. There is good dispersion of matrix and filler in the filled composites. The interaction between the matrix and filler is also good as shown in SEM images.

ULTIMATE TENSILE STRENGTH

Tensile test was performed in accordance with ASTM D3039, under displacement control using an UTM/E-40 with resolution of the piston movement of 0.01mm Table 3.1 .Test specimen were well filed to attain overall length and gauge length of 250 and 140mm respectively and an appropriate cross sectional area of 25×3 mm2 and aluminum tabs with dimensions of 55×25×1 mm with 45deg filing is done at the one end is glued.

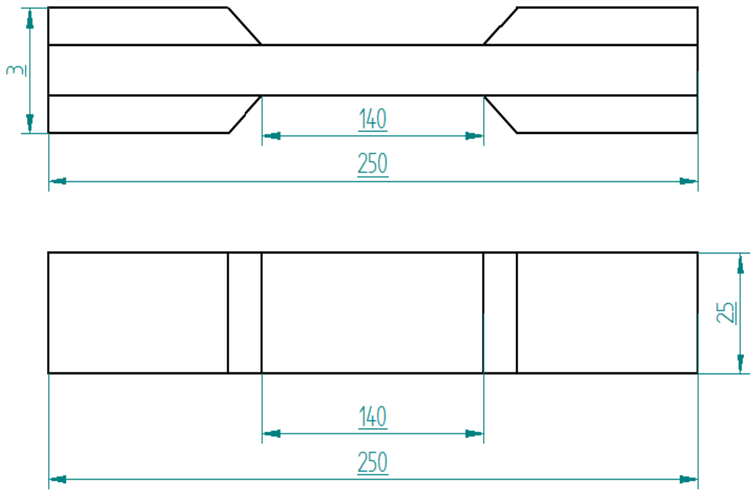

Figure 5: (All Dimensions are in mm) Tensile Specimen

Impact Test

The impact test specimen are made according to the specification of the ASTM E32 standards, the dimensions of the specimen are 10mmx10mmx55mm of size ,on one side surface of the specimen a V-notch is been made at an angle of 45deg with root depth of 2mm.

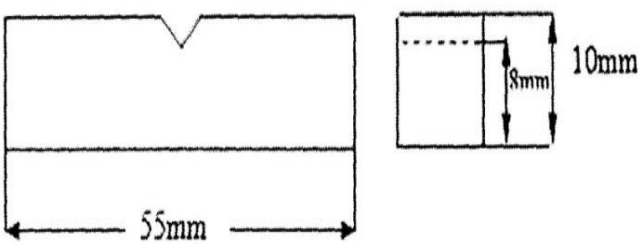

Figure 6: Charpy Impact Test Specimens as per ASTM E23 Standards

The test piece is simply supported at each end on anvils 40mm apart. A heavy pendulum is supported at one end in a bearing on the frame of the machine, and a striker is situated at the other end. The pendulum in its initially raised position has an available energy of 300J and on release swings down to strike the specimen immediately behind the notch, bending and fracturing in between the supports. A scale and pointer indicate the energy absorbed during fracture.

RESULTS AND DISCUSSIONS

Ultimate Tensile Strength

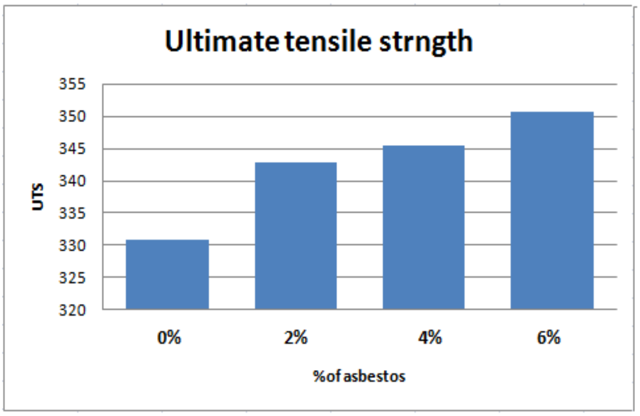

Figure 7: Comparison of UTS of Different Composites

Tensile test is carried out for unfilled glass/epoxy composite and for different proportions of asbestos filler i.e. 2%, 4%, and 6%. The results revealed that tensile strength for filled composite is higher compared to unfilled composite as shown in figure.6. It is clear that fracture is purely due to the fiber breakage. The fracture due to de-lamination of the fiber increased as the percentage of asbestos is increased because asbestos is layed up along with epoxy as the percentage of asbestos increases epoxy percentage decreases this is done to maintain constant volume of 300mmx300mmx3mm

Impact Test

Impact strength is obtained by dividing the energy absorbed (kg-m) by the cross sectional area of the specimen under the crack tip. Variation of the impact energy along and across the laminates for different composites is as shown in the graph.

Impact test is where in which rapid propagation of cracks without any excessive plastic deformation at a stress level below the yield stress of the material. Metals that show ductile behavior usually can, under certain circumstances, behave in a brittle fashion.

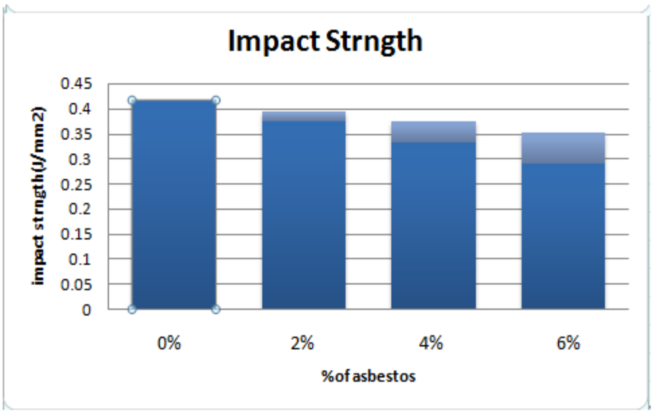

Figure 8: Comparison of Impact Strength of Different Composites

CONCLUSIONS

- All composite with filler material exhibited better mechanical properties than unfilled composites.
- As the filler percentage increased tensile strength and bending strength increased because asbestos influenced the

composite to enhance the ductility property.

- Increase in the percentage filler material decreased the impact strength because the filler material added does not support the enhancement of brittleness of the composite.

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